CORRECTIVE ACTION PLAN

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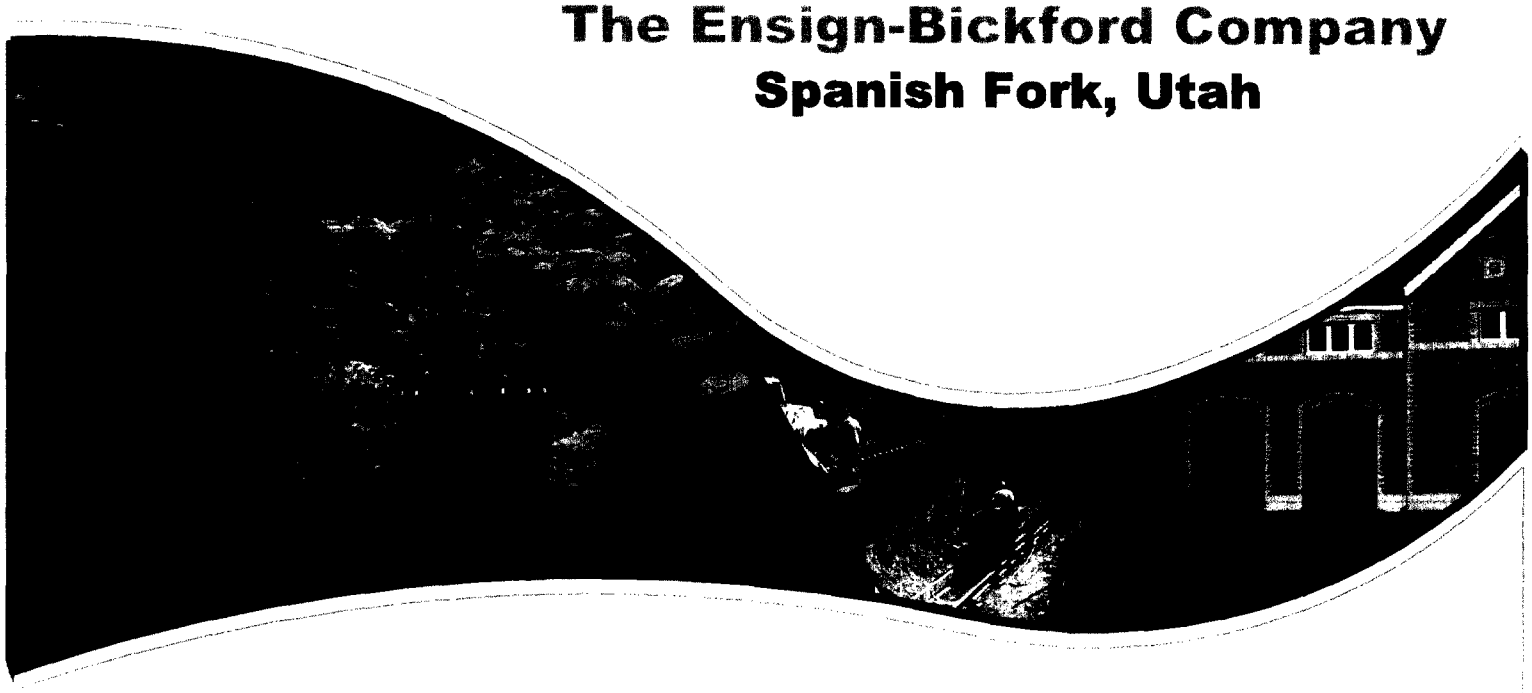
The Ensign-Bickford Company
Spanish Fork, Utah



CHARTER OAK

***Revised* May 2002**

SITE INVESTIGATION SUMMARY
AND
CORRECTIVE ACTION PLAN
THE ENSIGN-BICKFORD COMPANY
SPANISH FORK, UTAH

Prepared for:

The Ensign-Bickford Company
Spanish Fork, Utah
and
The Spanish Fork Technical Committee

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Revised
May 2002

EXECUTIVE SUMMARY

This revision of the Corrective Action Plan (CAP) is submitted in accordance with the amended Stipulation and Consent Order between the Utah Department of Environmental Quality, Division of Water Quality (DWQ) and The Ensign-Bickford Company (EBCo). The original CAP was submitted to DWQ on July 31, 2001. Revisions to the CAP have been made in response to comments received from DWQ in a letter dated January 17, 2002. The CAP has also been updated to include data collected during 2001. The CAP meets the requirements specified in Section R317-6.15 of the Utah Administrative Rules for Ground Water Quality Protection (DWQ, 1995). The CAP addresses corrective measures implemented to address nitrate-nitrogen and constituents of energetic materials (CEMs) that are present in the regional unconsolidated aquifer.

A ground water extraction and treatment system has been operating for over three years. The extraction well system consists of three recovery wells, an existing high volume irrigation well (Orton-23) and the Mapleton No. 1 well. Three granular activated carbon (GAC) treatment systems remove CEMs from the extracted ground water. The treated water is made available to Mapleton City and Spanish Fork City for use in their pressurized irrigation systems. Mapleton may also use the treated water from the Mapleton No. 1 well in its municipal potable water system, at its discretion. The extracted and treated ground water is being beneficially used. Excess water that is not used for irrigation, and water that is discharged during the non-irrigation season, is directed to Hobble Creek and the Spanish Fork River under UPDES Permits issued by DWQ.

The reduction of solute concentrations through natural attenuation processes is another component of the corrective action. The natural attenuation processes that are relevant in the regional unconsolidated aquifer reduce solute concentrations by dilution and dispersion.

The CAP provides a summary of existing hydrogeologic information and presents a review of the distribution, concentrations and trends of nitrate-nitrogen and CEMs in the ground water system. Environmental fate and transport factors that may affect these solutes are identified and described. An updated conceptual model of the hydrogeologic system is presented in this CAP. The conceptual model is a qualitative description of the hydrogeologic system and presents general information about the aquifer systems, perched ground water, ground water recharge and ground water flow directions.

Utah has established no ground water quality standards (R317-6-2, Table 1) for any of the CEMs that are present in ground water at this site. In accordance with section R317-6-6.15.F.2 of the Utah Administrative Rules for Ground Water Quality Protection, risk-based concentration limits (RBCLs) have been calculated for the CEMs. These RBCLs and other sources of information have been used to formulate proposed corrective action concentration limits (CACLs) for CEMs that have been identified in the regional unconsolidated aquifer. The proposed CACLs are conservative risk-based concentration levels calculated using the latest EPA methods. Alternatively, where a federal health

advisory (HA) exists for a compound, the HA may be proposed as the CACL. The proposed CACLs are concentrations at which there are no restrictions on the use of ground water.

Because the current HA for RDX is founded on inadequate science, no CACL is proposed for RDX at this time. Furthermore, RDX health-related information is currently being reviewed in a joint DOD/EPA program whose purpose is revision of the RDX IRIS file. Until such time that the DOD/EPA program RDX evaluation is completed, an interim water quality goal that is numerically equivalent to the HA for RDX is proposed.

Cleanup progress is being made, but due to a number of factors, including the heterogeneity of the regional aquifer and the limited duration of recovery system performance data, it is not possible to assess recovery system performance sufficiently to predict cleanup timeframes, at this time. An ongoing data collection and analysis program is proposed that through time will enable a meaningful assessment of the remedial measures. Monitoring data will be reviewed annually and reported to DWQ in an annual report. DWQ has already approved elements of the proposed monitoring program as described in correspondence dated November 6, 2001 and January 18, 2002.

The completed corrective action as identified in this CAP consists of six major components, as follows:

- Ground water extraction, GAC treatment and delivery to municipal pressurized irrigation systems and surface water discharge points;
- Natural attenuation;
- Institutional controls;
- Recovery system performance monitoring and assessment;
- Water quality monitoring; and,
- Annual Reporting.

This CAP provides sufficient qualitative and quantitative data supporting the proposition that the installed facilities, in addition to consideration of other relevant actions and factors as identified above, have resulted in an effective and complete remedy that satisfies the Utah ground water protection regulations.

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List of Acronyms

ACACL	Alternate Corrective Action Concentration Limit
2,4-DNT	2,4-Dinitrotoluene
2,6-DNT	2,6-Dinitrotoluene
BTTN	Butanetriol Trinitrate
CACL	Corrective Action Concentration Limit
CAP	Corrective Action Plan
CEM	Constituents of Energetic Materials
CHPPM	US Army Center for Health
CI	Contaminant Investigation
COC	Constituent of Concern
Comp A	RDX in a wax base
Comp B	A mixture of TNT and RDX
DDW	Division of Drinking Water
DEGDN	Diethylene Glycol Dinitrate
DEQ	Department of Environmental Quality
DOD	Department of Defense
DNR	Department of Natural Resources
DWQ	Division of Water Quality
DWR	Division of Water Rights
DSHW	Division of Solid and Hazardous Waste
EBCo	The Ensign-Bickford Company
EGDN	Ethylene Glycol Dinitrate
EPA	United States Environmental Protection Agency
ES	Engineering Science
HA	Health Advisory
HI	Hydrogeologic Investigation
HMX	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
IRIS	Integrated Risk Information System
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
MTD	Maximum Tolerated Dose
MWH	Montgomery Watson Harza
NG	Trinitroglycerol (nitroglycerin)
NIEHS	National Institute of Environmental Health Studies
NOAEL	Non Observed Adverse Effects Level
PELA	P.E. LaMoreaux and Associates
PETN	Pentaerythritol Tetranitrate
RBCL	Risk-Based Concentration Limit
RCRA	Resource Conservation and Recovery Act
RDX	Hexahydro-1,3,5-trinitro-1,3,5-triazine
RF	Regeneration Facility
RfD	Reference Dose
RFI	RCRA Facility Investigation
SMCL	Secondary Maximum Contaminant Level

List of Acronyms (continued)

SWMU	Solid Waste Management Unit
TEGDN	Triethylene Glycol Dinitrate
TMETN	TrimethylolethaneTrinitrate
TNT	2,4,6-Trinitrotoluene
TSNE	Total Specialty Nitrate Esters
USDASCS	United States Department of Agriculture Soil Conservation Service
USGS	United States Geological Survey

1.0 ABOUT THIS DOCUMENT

This document fulfills the Corrective Action requirements of R317-6-6.15 of the State of Utah Administrative Rules for Ground Water Quality Protection (DWQ, 1995). In accordance with the regulations, this Corrective Action Plan (CAP) contains the following major components:

- Characterization of the project study area
- Characterization of the constituents of concern
- Review of data used and identification of data gaps
- Proposed Corrective Action Concentration Limits (CACLs)
- Description of installed corrective measures
- Review of corrective measure performance
- Recommendations for future activities

1.1 Key Terminology

Several key terms are used throughout this document and are defined as follows:

Study Area – The area of interest addressed by this CAP (see Figure 6-2). The Spanish Fork River in the south, Hobble Creek in the north and the edge of the Wasatch Mountains to the east approximate the boundaries of the study area. The western boundary of the study area is considered to be just beyond the edge of ground water impacts.

Regional Unconsolidated Aquifer – A heterogeneous assemblage of saturated materials located in the unconsolidated basin-fill deposits west of the Wasatch Mountains. Also called the "*Regional Aquifer*" or "*Regional Ground Water Aquifer.*" The regional unconsolidated aquifer is the primary aquifer of interest for this CAP.

Deep Regional Aquifer – For the purposes of this CAP the deep regional aquifer represents the portion of the regional aquifer below an elevation of approximately 4,450 ± 50 feet. The Regional Aquifer is considered to be one aquifer having lateral and vertical heterogeneity. The qualifier "deep" does not indicate a separate aquifer.

Shallow Regional Aquifer – For the purposes of this CAP, the shallow regional aquifer represents portions of the regional aquifer from the top of the zone of saturation (regional water table) to an approximate elevation of 4,450 ± 50 feet. The Regional Aquifer is considered to be one aquifer having lateral and vertical heterogeneity. The qualifier "shallow" does not indicate a separate aquifer.

Mapleton Bench – A topographic feature present throughout much of the study area. It represents an area of highlands that lies between the Wasatch Mountains to the east and the lower elevation lake plane to the west.

Mapleton Bench Ground Water System – A perched ground water system present within the area of the Mapleton Bench. The ground water is perched on a laterally continuous clay layer that underlies the Mapleton Bench and separates the Mapleton Bench ground water system from the underlying regional aquifer. The Mapleton Bench ground water system is not part of the regional unconsolidated aquifer.

Foothills Recharge Area – An approximate area within the study area between the Spanish Fork River and Hobble Creek that is east of the Mapleton Bench and where recharge enters the regional aquifer.

Perched Ground Water – Ground water that is present in deposits above the top of the zone of saturation of the regional unconsolidated aquifer. If present, perched ground water generally collects on the top of less permeable layers. Perched ground water may or may not be a perched aquifer. The term aquifer applies to only those saturated deposits where sufficient water is consistently present and/or extractable to allow beneficial use of the ground water resource.

Hydrogeologic Investigation (HI) – The sequence of site investigation activities that have been performed to characterize the hydrogeology and to assess ground water impacts in the study area.

Natural Attenuation – Natural physical, chemical or biological processes that act to reduce the mass, toxicity, concentration, mobility, volume or concentration of constituents on soil or in ground water.

Dilution – A reduction of solute concentrations caused by the addition of clean ground water recharge to an aquifer.

Dispersion – Dispersion is mixing that occurs along a ground water flow path caused by the differing velocities of fluid particles. Dispersion results in the dilution of a solute at the advancing edge of flow.

Corrective Action Concentration Limit (CACL) – A cleanup standard for constituents that do not have established ground water quality standards. A CACL is a concentration at which there are no restrictions on the use of ground water. CACLs may be based on existing state or federal water quality standards, health advisories, risk-based concentration levels or other relevant information. For the purposes of this CAP, existing ground water quality protection standards for nitrate-nitrogen and dissolved lead are presented as CACLs.

Alternate Corrective Action Concentration Limit (ACACL) – A cleanup standard that is different than established ground water quality standards or approved CACLs. No ACACLs are proposed in this CAP.

Throughout this CAP, several different units are used to describe water volumes and flow rates. Flow rates (i.e. for wells) are usually expressed as *gallons per minute* (gpm) or may be expressed as *cubic feet per* second (cfs). When discussing recharge to and discharge from the ground water system, flow rates are generally provided in units of *acre-feet per year.* Water volumes in this CAP are given in units of *cubic feet, acre-feet* or *gallons.*

1.2 Document Organization

This CAP is organized as follows:

Section 2.0 provides an introduction to this project and briefly summarizes the corrective measures that have been implemented.

Section 3.0 of this document identifies the objectives of the CAP.

Section 4.0 provides information about production activities at the site, the regulatory context for the CAP and the history of site investigations.

Section 5.0 presents a simplified conceptual model of the hydrogeologic system in the study area. A conceptual model is a qualitative description of the hydrogeologic system. The conceptual model presented herein provides a basis for understanding the distribution and migration of solutes in the hydrogeologic system.

Section 6.0 provides a characterization of the study area including information about climate, soils, hydrogeology, general water chemistry and possible source areas for ground water impacts to the regional aquifer.

Section 7.0 provides information about the environmental fate, transport, concentration and distribution of solutes in the regional ground water aquifer.

Section 8.0 of this document presents a qualitative review of the analytical data used in the preparation of this CAP.

Section 9.0 addresses proposed Corrective Action Concentration Limits (CACLs) for constituents of concern. Ground water quality standards have not been established for CEMs. Proposed CACLs for the CEMs are based on the risk-based concentration levels calculated by Dr. Brian Murphy using current EPA methods. The Dr. Murphy report is provided in Appendix E.

Section 10.0 describes the corrective action consisting of a combination of ground water extraction and treatment and natural attenuation.

Section 11.0 provides a review of the existing corrective action, based upon data collected since the start of ground water extraction and treatment activities.

Section 12.0 presents recommendations for the ongoing operation and assessment of the corrective action.

Section 13.0 is the list of references cited.

2.0 INTRODUCTION

Concentrations of nitrate-nitrogen and several constituents of energetic materials (CEMs) have been detected in private wells, municipal wells and monitoring wells in the area of The Ensign-Bickford Company (EBCo) facility in Spanish Fork, Utah. The zone of impact is elongated with the long axis of the affected region orientated in a northerly direction and extending approximately three miles from the plant site.

A phased hydrogeologic investigation, including soil borings, monitoring well installation and environmental sampling has been performed since 1986. Trojan Corporation (Trojan), then a subsidiary of Ensign-Bickford Industries, performed initial investigation work under the guidance of the Utah Department of Environmental Quality (DEQ). Since 1991, the phased hydrogeologic investigation activities have been performed in accordance with the provisions of a consent agreement between EBCo and the Utah Division of Water Quality (DWQ). The phased hydrogeologic investigation fulfills the requirements for a Contaminant Investigation (CI) as defined in the Utah Administrative Rules for Ground Water Quality Protection (UAC R317-6-6.15.D). This compilation of hydrogeologic and other data addresses the following three key components of the CI:

- Characterization of the project study area
- Characterization of constituents of concern
- Data report

This information is also used to develop a conceptual model of the hydrogeologic system in the study area. The conceptual model is a qualitative description of the hydrogeologic system that depicts the hydrologic conditions controlling ground water movement and solute transport. A substantial body of data has been collected since 1995 when the initial conceptual model was developed and submitted to DWQ in the Phase IV Hydrogeologic Investigation Report (Owens Western, 1995a). This post-1995 data and interpretations thereof warrant the preparation of a revised conceptual model to support the CAP.

Additionally, EBCo, in conjunction with prior owners of the site, have implemented substantial corrective measures to address ground water quality impacts. While initially conceived as "interim measures," the installed corrective measures are more comprehensive than originally proposed in the Interim Measures Work Plan (Owens Western, 1996b) and are proposed as the final corrective action. These activities include the following:

- Reactivation of the Mapleton No. 1 well so that water from this well may be beneficially used in the municipal potable water supply system, a municipal pressurized irrigation system or be directed to Hobble Creek when the water is not used by Mapleton City.

- Rehabilitation and activation of the Orton-23 private irrigation well for ground water extraction purposes.

- Installation of three extraction wells for ground water recovery purposes.

- Construction of three granular activated carbon (GAC) treatment systems to remove CEMs from ground water extracted from the Mapleton No. 1 well, the Orton-23 well and the ground water recovery wells.

- Installation of over 40,000 linear feet of 4-inch to 30-inch pressurized piping for recovered ground water conveyance and pressurized irrigation use. The installed infrastructure is designed so that the recovered and treated ground water may be beneficially used in community pressurized irrigation systems.

- Ongoing ground water monitoring and reporting in accordance with an approved data collection plan.

The combined maximum flow rate of all wells connected to the recovery system is approximately 2,200 to 2,500 gpm. This flow rate approximates the safe annual yield estimated for the study area by the Department of Natural Resources (DNR) at DWQ's request (Letter from DWQ dated May 8, 1996).

A RCRA Facility Investigation (RFI), being managed by Charter Oak with assistance from Montgomery Watson Harza (MWH), formerly Montgomery Watson, is presently underway to evaluate conditions at the EBCo site. The primary purpose of the RFI is to identify and characterize impacts to on-site soils and ground water. Data collected during the RFI will be used to develop corrective measures that may be necessary to protect human health, ecological health and the environment. Of particular interest to the CAP is an evaluation of what on-site soil or ground water impacts, if any, may be acting as continuing sources of constituents to the regional unconsolidated aquifer. Although the RFI process is not yet complete, a preliminary assessment of potential impacts to ground water has been made based on the available data.

In this case, an interim measure corrective action has been in place prior to the submission of the CAP. This is beneficial because data collected to assess recovery system performance are available for presentation in the CAP. This document presents a detailed review of completed and operational remedial measures and an assessment of recovery system performance since recovery activities began and evaluates such performance in the context of the CAP.

3.0 OBJECTIVES

The purpose of this document is to present a Site Investigation Summary and a Corrective Action Plan which meets the corrective action requirements promulgated in Section R317-6-6.15 of the Utah Administrative Rules for Ground Water Quality Protection (DWQ, 1995). This CAP meets these objectives, in that it:

- Presents a brief background of site history and conditions with particular emphasis on historical discharges and/or current conditions. A review of pertinent regulatory involvement is presented which sets the stage for the preparation of this CAP. A summary of past hydrogeologic investigation activities is also provided.

- Provides a characterization of the study area, which includes general information about climate, land use, surface waters and geography. Information is provided regarding hydrogeologic conditions within the project study area, as is information about possible source areas for nitrates and CEMs identified in ground water.

- Identifies and provides characterization of the constituents of concern including information about the concentration, form, toxicity, environmental fate and transport, distribution and other significant characteristics of the substances present.

- Presents a revised conceptual model of the study area that describes the conceptual hydrogeologic system and the effect that the hydrogeology has on ground water flow and solute distribution.

- Presents a general, qualitative review of information gathered during the ongoing RFI with an emphasis on the potential for continuing impacts to the regional unconsolidated aquifer.

- Presents a data report reviewing the data used to develop the report, descriptions of data gaps that may be present and a discussion of possible data limitations.

- Proposes corrective action concentration limits (CACLs) for those constituents of concern where no ground water quality standard (R317-6-2, Table 1) exists. In this case, this represents the CEMs detected in the regional aquifer. For RDX, an interim water quality goal that is numerically equivalent to the RDX Health Advisory is established due to current inadequate science to establish a CACL. In accordance with R317-6-6.15.D.1.d. an endangerment assessment necessary to support the proposed CACLs is also provided.

- Provides a detailed description of the operating corrective measures, including extraction wells, treatment systems and water conveyance and delivery systems. The plan demonstrates how the corrective measures address the applicable

approval criteria identified in UAC R317-6-6.15.E. Because the corrective measures are already operational, a summary of actual recovery system performance data (water level trends, containment area assessment, water quality trends) is provided.

- Outlines plans and objectives for ongoing operations and maintenance of ground water recovery and treatment facilities, recovery system performance monitoring, water quality monitoring and reporting.

4.0 BACKGROUND

This section presents a brief history of site development and operations, a review of the regulatory context of this CAP and a summary of previous site investigation activities that directly support the preparation of the CAP. More details about facility history, manufacturing operations and waste management practices may be found in the RCRA Facility Investigation Work Plan (Montgomery Watson, 1998).

4.1 Site Operational History

4.1.1 Manufacturing Operations

The site was developed in approximately 1940 by the Illinois Powder Manufacturing Company. Originally the facility manufactured nitroglycerin (NG) and nitroglycerin-based products from 1941 until 1963, at which time NG production ceased following a detonation at the nitroglycerin storage building. Nitrostarch operations began in approximately 1964 and continued until 1976. PETN formulation began in late 1966 and Pentolite (a mixture of PETN and TNT) production began in 1968 and both remain the primary manufacturing activities today. RDX operations involving Composition A (Comp A) began in 1971 and continued through the mid to late 1970's. RDX operations involving Composition B (Comp B) began in approximately 1980 and continued until approximately 1986. Specialty nitrate production (EGDN, DEGDN, TEGDN, BTTN, TMETN) began in 1976 and continued intermittently until approximately 1991. NCN (a mixture of ammonium nitrate and fuel oil) production began prior to 1963 and continued until 1982. NTO and TNC were produced on a very limited basis from 1987 until 1991. The RFI Work Plan (Montgomery Watson, 1998) provides detailed descriptions of the various manufacturing activities that have occurred at the Plant and that information will not be reproduced in this CAP.

One item that was not addressed in the RFI Work Plan relates to the manufacture of NG. Through a review of the manufacturing process for NG, it has been determined that the NG produced at the Plant was approximately a 50/50 mixture of NG and EGDN. This is because both glycerin and ethylene glycol were nitrated to produce an NG/EGDN mixed product. EGDN was desirable in the finished product due to its lower freezing point. Wastewater discharges to the ground from the production of NG/EGDN would have contained both NG and EGDN. Based on the aqueous solubility of these compounds, the NG to EGDN ratio in the wastewater discharge would have been approximately one to four (1:4). It is understood in this document that references to NG production mean a finished product mixture of NG and EGDN.

Based on historic research and a review of RFI data, potential impacts from site-related activities were identified at primarily two locations:

1. The northwest impoundment, an unlined surface impoundment, located in the northwest portion of the site. This area was used in conjunction with the nitroglycerin and nitrostarch processes from approximately 1941 until 1976. This area is within SWMU 26.

2. The unlined wastewater conveyance structure, north impoundment and wastewater dispersion area, located in the northeast portion of the site. These areas were used during nitroglycerin, PETN, specialty nitrate and RDX operations from approximately 1941 until 1991, when a permitted wastewater treatment facility was installed at the site. This area is SWMU 1. Several other SWMU's associated with manufacturing operations are also located in this general area.

In addition, potential off-site ground water impacts may have resulted from the use of nitric acid storage ponds. The first acid pond developed a small tear in 1982 resulting in the loss of a small, unknown amount of dilute nitric acid to the subsurface. A loss of approximately 10,000 gallons of dilute nitric acid to the subsurface occurred from this same pond in 1985. An incident occurred at the second pond in June 1986 resulting in the loss of approximately 752,000 gallons of dilute (approximately 23%) nitric acid to the subsurface. Since 1986, acids have been temporarily stored on-site in tanks and removed for recycling by a third party vendor. This practice continues to the present day.

These areas, along with numerous other areas at the EBCo site, are subject to investigation as part of the RFI. Corrective measures, if necessary, addressing soil quality impacts at these locations, including the potential for constituents in soil to impact the regional aquifer, will be managed under the RCRA Corrective Action program.

4.2 Regulatory Context

This CAP is submitted to fulfill Step 3 of the 1991 Consent Order between EBCo and DWQ, as modified by the July 10, 2000 Consent Order Addendum.

4.3 History of Environmental Investigation

This section identifies the various site investigation resources used to prepare the hydrogeologic investigation summary and to develop the updated conceptual model of the study area. A list of pertinent reports and documents is provided.

4.3.1 P.E. LaMoreaux & Associates, Inc.

P.E. LaMoreaux & Associates, Inc. (PELA) was retained by IMC (Mallinckrodt) in the late 1970's to assess environmental conditions at the Plant. PELA reviewed and summarized general information available about the local geology and hydrogeology of the area. PELA also reviewed historic and ongoing manufacturing and materials

management practices at the Plant and identified possible source areas for ground water impacts. Actual physical investigation activities included the installation of a series of shallow soil borings and monitoring wells (the B-series wells) in the northeast portion of the Plant. One purpose of these soil borings and wells was to aid in the design of a lined storage impoundment for management of dilute nitric acid from PETN manufacturing operations.

PELA's geologic and hydrogeologic information (e.g. soil borings and well drilling data) has been supplemented with more detailed information that has since been developed through additional site investigation activities. The PELA documents also provide insight into historic waste management practices at the Plant as well as a review of several active manufacturing processes during 1980 including: TMETN production, RDX dewaxing, RDX crystallization, PETN crystallization and PETN nitration.

4.3.2 Engineering Science, Inc.

Engineering Science, Inc. (ES) was retained by Trojan to evaluate the potential effects that the 1986 pond incident may have had on area ground water quality. This investigation work was performed voluntarily and in cooperation with DWQ. The ES investigation focused exclusively on the presence of nitrate in ground water. In addition to a detailed review of general geologic and hydrogeologic information, ES performed an extensive review of lithologic information from well logs in the area. ES also installed six monitoring wells (MW-1S, MW-1D, MW-2S, MW-3D, MW-5S, MW-5D) to assess the potential for off-site ground water impacts and to determine the hydraulic characteristics of off-site aquifer materials. ES also undertook an extensive off-site nitrate sampling program to identify the nature and distribution of potential nitrate impacts.

Based on the investigation work and nitrate distribution, ES formulated the fault zone migration hypotheses which postulated that nitrates migrated from the Plant to the north within the Wasatch Fault Zone.

4.3.3 Dames & Moore

Trojan retained Dames & Moore in approximately 1990 to prepare the Hydrogeologic Investigation Plan (HIP), which formalized the phased hydrogeologic investigation from which this CI/CAP is largely developed. Dames & Moore also completed Phase Ia of the hydrogeologic investigation which consisted of the mapping of faults, bedding planes and fractures in bedrock to the east of the Plant and the installation and packer testing of a bedrock boring into consolidated rock northeast of the Plant. Dames & Moore also initiated two on-site investigations of soils in the North Impoundment and PETN Pack House areas under the direction of DSHW.

4.3.4 Owens Western Company

Owens Western Company (Owens Western) began work on the project in 1991. Owens Western performed the remaining major tasks identified in the HIP including monitoring well installation, hydrogeologic analysis and interpretation, water quality sampling, ground water flow and mass transport modeling and preparation of the "Off Site Contamination Feasibility Study". Owens Western also prepared an Interim Measures Work Plan proposing corrective measures to address off-site ground water impacts and institutional controls to address the potential for public exposure to impacted ground water.

4.3.5 Consulting Environmental Engineers, Inc.

Consulting Environmental Engineers, Inc. (CEE) primarily provided engineering support to Trojan and Owens Western. CEE was the design engineer for the ground water recovery system that has been installed. CEE also produced a document summarizing various water management alternatives for waters to be discharged from the proposed recovery wells. Through this analysis it was determined that the preferred water management alternative involved GAC treatment of the recovered water and subsequent use in municipal pressurized irrigation systems or surface water discharges. Nitrate treatment, wetlands remediation, underground injection, phytoremediation and sewer discharge were also evaluated during this process. CEE also served as the Project Coordinator for EBCo and the prior owners for a short period of time.

4.3.6 Charter Oak Environmental Services, Inc.

Charter Oak Environmental Services, Inc. (Charter Oak) began working on this project in November 1997, primarily as the Project Coordinator. Charter Oak assumed Owens Western responsibilities in July 1998 and has facilitated the construction of the ground water recovery, treatment and conveyance facilities, operation and maintenance of those facilities, continued hydrogeologic investigation, water quality monitoring, implementation of institutional controls, regulatory reporting and preparation of the CI/CAP. Charter Oak prepared the Nitrate and RDX Fate and Distribution Report (Charter Oak, 1998), which characterized the distribution and behavior of nitrate and RDX (as representative of all CEMs) in the regional aquifer within the study area.

4.3.7 Montgomery Watson Harza

Montgomery Watson Harza has been working at the EBCo site since 1998 and is performing RCRA Facility Investigation (RFI) activities at the Plant. Hundreds of soil samples have been collected during the RFI to assess the quality of on-site soils. Several monitoring wells have been installed to assess water quality conditions in both perched ground water and the regional aquifer below the Plant site. The RFI program is being

conducted with project management by Charter Oak and under the auspices of the Utah Division of Solid and Hazardous Waste (DSHW).

4.3.8 Relevant Site Investigation Reports

Table 4-1 presents a list of reports characterizing on- and off-site geology, hydrogeology, water quality, soil quality, environmental fate and behavior and potential remedial alternatives.

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Table 4-1: Site Investigation Reports

Consultant	Date	Title
P.E. LaMoreaux & Associates	1979	A Hydrogeologic Evaluation of the IMC Springville Plant Site, Utah, Phase I
P.E. LaMoreaux & Associates	1980	Preliminary Investigation of Waste Management at the IMC Springville Plant, Phase II
P.E. LaMoreaux & Associates	1981	A Hydrogeologic Evaluation of the IMC Springville Plant Site, Utah, Phase III
P.E. LaMoreaux & Associates	1981	Hydrogeologic Evaluation of the IMC Springville Plant Site, Utah, Phase IV
Engineering Science, Inc.	1989	Hydrogeologic Assessment Program
Engineering Science, Inc.	1990	Hydrogeologic Assessment Program
Dames & Moore	1991	Hydrogeologic Investigation Plan
Dames & Moore	1992	Phase Ia Hydrogeologic Investigation Report
Owens Western Company	1992	Phase Ib Hydrogeologic Investigation Report
Owens Western Company	1993	Phase II Hydrogeologic Investigation Report
Owens Western Company	1994	Phase III Hydrogeologic Investigation Report
Owens Western Company	1995	Phase IV Hydrogeologic Investigation Report
Owens Western Company	1995	Off-site Contamination Feasibility Study
Owens Western Company	1996	Supplemental Hydrogeologic Investigation Report
Owens Western Company	1996	Phase I Interim Measures Work Plan
Owens Western Company	1997	R-3 Well Construction and Pump Test Report
Consulting Environmental Engineers, Inc	1997	An Evaluation of Wastewater Management Alternatives
Charter Oak Environmental	1998	Data Collection Plan
Charter Oak Environmental	1998	Nitrate and RDX Distribution and Fate Report
Charter Oak Environmental	1998	R-1, R-2 and Orton-23 Well Construction and Pump Test Reports
Charter Oak Environmental	1998	Well Head Protection Plan
Montgomery Watson	1998	Final Revised RFI Work Plan
Montgomery Watson	2000	EBCo RFI SWMU-Specific Figures and Data Tables from Surface Soil, Soil Boring and Trenching Locations
Charter Oak Environmental	2000	1999 Annual Report
Charter Oak Environmental	2000	2000-1 and 2000-2 Quarterly Reports
Charter Oak Environmental	2000	2000-3 Quarterly Report
Charter Oak Environmental	2000	LB-1 Boring Report
Charter Oak Environmental	2001	Corrective Action Plan
Charter Oak Environmental	2001	2001-1 and 2001-2 Quarterly Reports
Charter Oak Environmental	2001	2001-3 Quarterly Report
Charter Oak Environmental	2001	Orton-23 Recovery Well Packer Test Report
Montgomery Watson	2001	EBCo RFI SWMU-Specific Figures and Data Tables from Supplementary Surface Soil, Soil Boring and Trenching Locations

5.0 CONCEPTUAL MODEL

A conceptual model is a simplified and qualitative presentation of the real hydrogeologic system. The conceptual model presented herein identifies the key factors that affect ground water movement and solute migration in the study area. Figure 5-1 is a block diagram illustrating a simple and idealized conceptual model for the study area. This conceptual model is consistent with the hydrogeologic and water quality data available for the study area that are summarized in Sections 6 and 7 of this CAP.

Three aquifer systems are present in the study area: the bedrock regional aquifer; the regional unconsolidated aquifer; and, the perched Mapleton Bench ground water system. Other localized areas of perched ground water, above the regional unconsolidated aquifer system, are present within the study area and at the Plant site. The unconsolidated regional aquifer is the primary focus of this CAP.

The unconsolidated regional aquifer system consists of a heterogeneous mixture of clay, silt, sand and gravel deposited by lacustrine, fluvial and alluvial processes. The transmissivity of the regional aquifer varies over three orders of magnitude with relatively lower permeability deposits found along the basin edge near the EBCo site and higher permeability deposits found in the western and northern portions of the study area. The unconsolidated regional aquifer is considered to be unconfined. Locally confined conditions may be present in some areas.

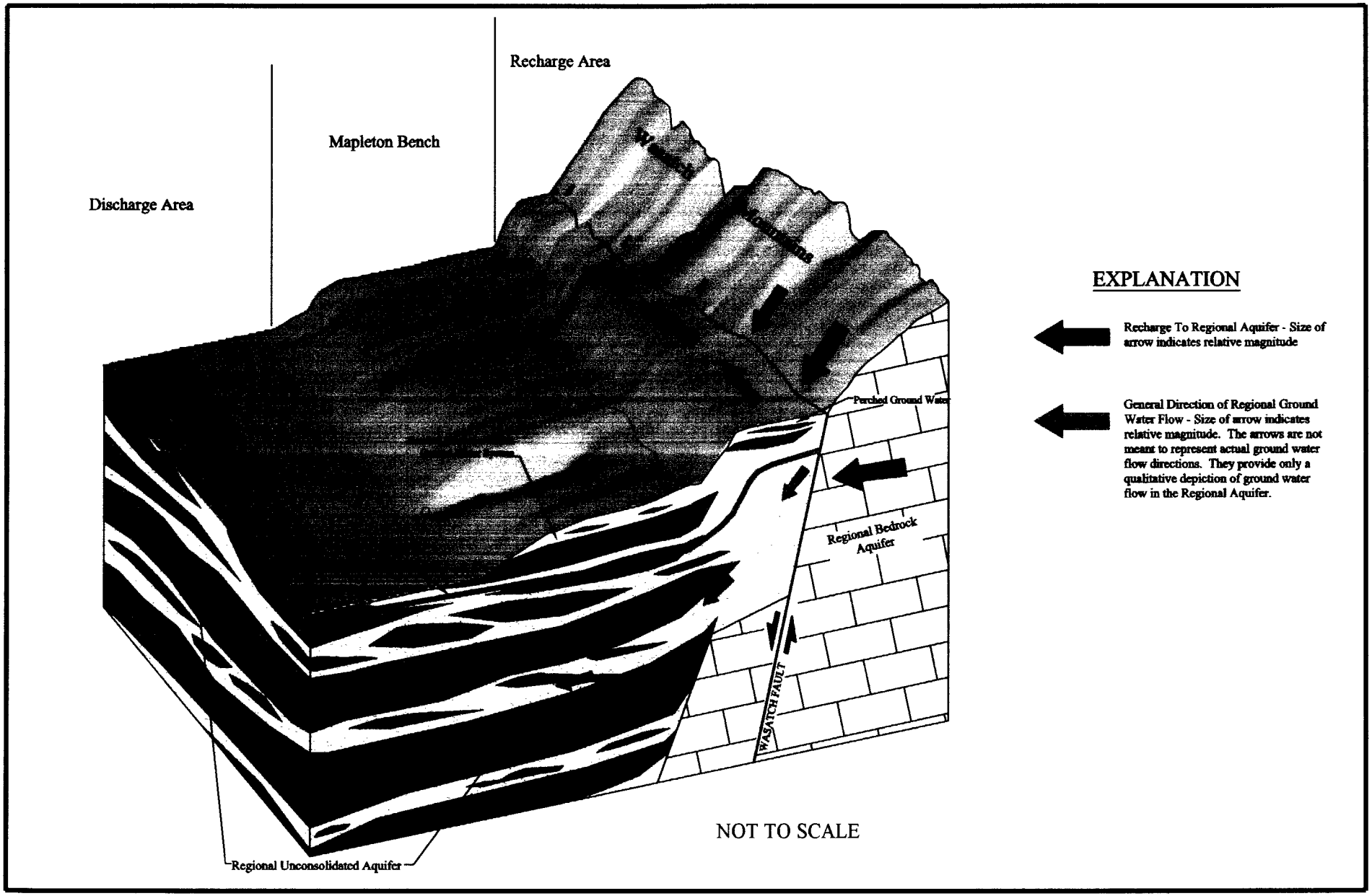
According to Brooks and Stolp (1995), the Mapleton Bench ground water system is perched atop a laterally continuous clay layer that contains some localized mixtures of silts and sands. The underlying clay layer separates the Mapleton Bench ground water system from the regional aquifer system. The Mapleton Bench ground water system extends from the edge of foothills recharge area westward across the study area. It extends a short distance to the north of Hobble Creek and is not found south of the Spanish Fork River. Ground water within the Mapleton bench ground water system discharges to springs, Hobble Creek and the Mill Race Canal and does not recharge the regional aquifer.

Due to the presence of the Mapleton Bench ground water system, recharge to the regional unconsolidated aquifer system in the study area occurs primarily in the foothills recharge area, near the mouth of Spanish Fork Canyon and along the Hobble Creek stream channel. Based on data reported by Brooks and Stolp (1995), Hobble Creek and the Spanish Fork River, located along the northern and southern boundaries of the study area, contribute about 43 percent of the total annual recharge to the main ground water system, with the volume split nearly evenly between these two perennial streams. Recharge due to the infiltration of intermittent and ephemeral runoff, precipitation and applied irrigation water occurs in the foothills recharge area. These sources account for about 12 percent of the total annual recharge to the regional aquifer in the study area. The remaining 45 percent of the recharge is from subsurface inflow from the bedrock aquifer along the eastern boundary of the study area. Aside from pumping wells, discharge out of the study area is generally to the west toward Utah Lake.

The distribution and relative magnitude of the recharge is of particular importance to the conceptual model. Based on data provided by Brooks and Stolp (1995), approximately 98 percent of the subsurface inflow enters the regional aquifer system in the southern one third of the study area. Less than about 2 percent of the subsurface inflow recharges the regional aquifer in the northern two thirds of the study area. Approximately 16 percent of the total subsurface inflow enters the regional aquifer system at the mouth of Crowd Canyon, alone. The distribution and magnitude of recharge due to intermittent and ephemeral runoff and precipitation is more evenly distributed within the foothills recharge area, with the locally highest volume at the mouth of Crowd Canyon where approximately 6 percent of the total recharges the regional aquifer. The green arrows in Figure 5-1 represent recharge to the unconsolidated regional aquifer in the foothills recharge area. The size of the arrows provides an indication of the relative magnitude of the recharge.

As shown in Figure 5-1, most regional aquifer ground water flow in the study area has a northerly direction approximately parallel to the Wasatch Mountains before flowing toward Utah Lake. Also, as shown in Figure 5-1, some westerly flow of ground water is conceptualized. Ground water discharge out of the study area is generally toward Utah Lake. A component of downward vertical ground water flow is present in the recharge area as shown in Figure 5-1. Further to the west below the area of the Mapleton Bench, ground water flow is nearly horizontal. The water table tends to steepen at the eastern margin of the basin as a result of recharge and tends to flatten toward the central part of the valley where little, if any, recharge occurs.

Transmissivity variations in the regional aquifer and the distribution of recharge sources combine to form ground water flow in all directions from the west to the northeast in the unconsolidated basin fill deposits.



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Conceptual Model of Ground Water Flow in the Regional Unconsolidated Aquifer

FIGURE 5-1